FORM PTO-1390 (REV. 5-93) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 10191/2363
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	U.S. APPLICATION NO. (If known, see 37 CFR 1 5) To Be Assigned 10/089388

INTERNATIONAL APPLICATION NO. PCT/DE00/02478	INTERNATIONAL FILING DATE 28 July 2000 (28.07.00)	PRIORITY DATE CLAIMED: 29 September 1999 (29.09.99)

TITLE OF INVENTION
METHOD AND DEVICE FOR BIDIRECTIONAL COMMUNICATION BETWEEN AT LEAST TWO COMMUNICATION SUBSCRIBERS

APPLICANT(S) FOR DO/EO/US
DROBNY, Wolfgang; MORITZ, Rainer; and STRAUB, Bernhard

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U S C 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U S C 371.
3. ☒ This is an express request to begin national examination procedures (35 U S C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U S.C 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau)
   b. ☒ has been transmitted by the International Bureau
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have. been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) (unsigned).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☒ A substitute specification and marked-up version thereof.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report (translated, International Preliminary Examination Report (translated) and Form PCT/RO/101.

Express Mail No. ~~EL394613604~~ EL594613564US

JC13 Rec'd PCT/PTO 29 MAR 2002

U.S. APPLICATION NO (if known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/089388	PCT/DE00/02478	10191/2363

17. ☐ The following fees are submitted.

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search Report has been prepared by the EUROPEAN PATENT OFFICE or JPO $890.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) $710 00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1 445(a)(2)) $740 00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,040.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00

				CALCULATIONS	PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 890	
Surcharge of $130 00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1 492(e))				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	11 - 20 =	0	X $18.00	$ 0	
Independent Claims	2 - 3 =	0	X $84 00	$ 0	
Multiple dependent claim(s) (if applicable)			+ $280 00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 890	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 890	
Processing fee of $130 00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1 492(f)). +				$	
TOTAL NATIONAL FEE =				$ 890	
Fee for recording the enclosed assignment (37 CFR 1 21(h)) The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3 31) $40 00 per property +				$	
TOTAL FEES ENCLOSED =				$ 890	
				Amount to be refunded	$
				charged	$

a. ☐ A check in the amount of $__________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$890.00** to cover the above fees A duplicate copy of this sheet is enclosed.

c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
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SIGNATURE

Richard L. Mayer, Reg. No 22,490
NAME

3/28/2002
DATE

CUSTOMER NO. 26646

[10191/2363]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Wolfgang DROBNY et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	METHOD AND DEVICE FOR BIDIRECTIONAL COMMUNICATION BETWEEN AT LEAST TWO COMMUNICATION DEVICES
Art Unit	:	To Be Assigned
Examiner	:	To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Please amend without prejudice the above-identified application before examination, as set forth below.

IN THE TITLE:

Please amend without prejudice the title to be:

--METHOD AND DEVICE FOR BIDIRECTIONAL COMMUNICATION BETWEEN AT LEAST TWO COMMUNICATION DEVICES--.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

Without prejudice, please cancel original claims 1 to 11 and new/substitute claims 1 to 9, and please add new claims 12 to 22 as follows:

EL946135564

--12. (New) A method for providing bidirectional data transmission between at least two communication devices, the method comprising:

transmitting data on a single communication path in one communication direction via a change in a current flow;

transmitting data simultaneously on the single communication path in an opposite communication direction via a change in a voltage;

providing the single communication path by one of maintaining a separate power supply for each of the at least two communication devices and implementing a single power supply for both communication directions by providing a steady minimum level of at least one of the voltage and the current flow;

generating the data to be transmitted via a change in the current flow as data pulses with an inverted pulse half and a non-inverted pulse half; and

encoding the data pulses with a pulse-edge change between the pulse halves using Manchester coding.

13. (New) The method of claim 12, further comprising:

setting a high voltage level, a low voltage level, and an intermediate voltage level, wherein data transmitted by the change in the voltage is represented by changing between the high voltage level and the intermediate voltage level.

14. (New) The method of claim 13, wherein a minimum level corresponds to the intermediate voltage level.

15. (New) The method of claim 12, further comprising:

setting a high voltage level and a low voltage level, wherein data transmitted by the change in the voltage is represented by changing between the high voltage level and the low voltage level.

16. (New) The method of claim 12, further comprising:

generating the data to be transmitted via the change in the voltage as data pulses with an inverted pulse half and a non-inverted pulse half; and

encoding the data pulses with an edge change between the pulse halves using a cyclic code.

17. (New) A device for providing bidirectional data transmission between at least two communication devices, the device comprising:

a first arrangement to transmit data on a single communication path in one communication direction via a change in a current flow;

a second arrangement to simultaneously transmit data on the single communication path in an opposite communication direction via a change in a voltage;

one of a separate power supply for each of the at least two communication devices and a single power supply for both communication directions, the single power supply being operable to provide a constant minimum level of at least one of the voltage and the current flow; and

a fourth arrangement to generate data pulses with an inverted pulse half and a non-inverted pulse half, and to code the data pulses with an edge change between the pulse halves using a Manchester coding, the data pulses implementing at least the data to be transmitted via the change in the current flow.

18. (New) The device of claim 17, further comprising:

a third arrangement to perform the change in the voltage, wherein a high voltage level and a low voltage level is set, and the data is represented by changing between the high voltage level and the low voltage level;

wherein there is a separate power supply for each of the communication directions.

19. (New) The device of claim 17, further comprising:

a third arrangement to provide the change in the voltage, wherein a high voltage level, a low voltage level, and an intermediate voltage level is set, and the data is represented by changing between the high voltage level and the intermediate voltage level.

20. (New) The device of claim 17, further comprising:

a fifth arrangement to generate data pulses with an inverted pulse half and a non-inverted pulse half, and to encode the data pulses with an edge change between the pulse halves using a cyclic code, the data pulses implementing at least the data to be transmitted via the change in voltage.

21. (New) The device of claim 20, wherein the cyclic code includes one of a Manchester code, a Hamming code, and an Abramson code.

22. (New) The method of claim 16, wherein the cyclic code includes one of a Manchester code, a Hamming code, and an Abramson code.--.

Remarks

This Preliminary Amendment cancels without prejudice original claims 1 to 11 and new/substitute claims 1 to 9 in the underlying PCT Application No. PCT/DE00/02478, and adds without prejudice new claims 12 to 22. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(iii) and § 1.125(b)(2), a Marked Up Version Of The Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. In the Marked Up Version, underlining indicates added text and bracketing indicated deleted text. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE00/02478 includes an International Search Report, dated March 27, 2001. The Search Report includes a list of documents that were uncovered in the underlying PCT Application. A copy of the Search Report accompanies this Preliminary Amendment.

The underlying PCT application also includes an International Preliminary Examination Report, dated January 17, 2002, and an annex (including new/substitute claims 1 to 9). An English translation of the International Preliminary Examination Report and the annex accompanies this Preliminary Amendment.

Applicants assert that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,

KENYON & KENYON

Dated: 3/28/2002

By: Richard Mayer (By Reg. No. 33,865 Aaron C. Deditch)

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METHOD AND DEVICE FOR BIDIRECTIONAL COMMUNICATION BETWEEN AT LEAST TWO COMMUNICATION DEVICES

FIELD OF THE INVENTION

The present invention relates to a method and a device for providing bidirectional data transmission between at least two communication devices including data transmitted between a peripheral device and a controller in an airbag system.

BACKGROUND INFORMATION

In this regard, German Published Patent Application No. 196 09 290 discusses an airbag system for protecting the occupants of a vehicle. A plurality of sensor modules may be connected via pairs of lines to a controller arranged at a distance. The controller may control a restraint device for vehicle occupants such as an airbag, for example. The output signals of the sensor modules may be transmitted to the controller in the form of sequential changes in the current flow on both lines, i.e., in the form of analog push-pull signals or in the form of a pulse train. In the opposite direction, namely from the controller to the sensor modules, the data may be implemented by sequential changes in voltage. The communication occurs with a time offset, i.e., the controller may signal the start of transmission to the sensor modules on the basis of a request signal in the form of sequential changes in voltage, and following that in the opposite direction, i.e., from the sensor modules to the controller, data may be transmitted in the form of sequential changes in current flow via the line pair.

With regard to the current interface, wherein the direction of transmission may flow from the sensor modules to the controller, German Published Patent Application No.

198 13 965, discusses a method of transmitting digital data with a clock acceptance generator whose clock frequency may be controllable. Data transmission from a peripheral device to a controller via signal edges of the current flow in a special shape may be described here. The coding of the binary states may thus be defined by a rising or a falling signal edge, which may need to be detected in a certain time window. Through the additional use of Manchester coding, the data acceptance clock generator frequency may be synchronized. The time shift, occurring here between the data pulses and the synchronization times of the pulse-edge changes, may be taken into account by a time-offset sampling of the logic levels of the data pulses. If a bidirectional transmission according to this method were used, a time-offset data transmission may also have to be used here.

In addition to the Manchester or Manchester II coding mentioned above, there are other coding methods, in particular cyclic coding methods, in data transmission technology, e.g., the Hamming code or the Abramson code, etc.

SUMMARY OF THE INVENTION

An object of an exemplary embodiment of the present invention involves providing simultaneous bidirectional data transmission in both directions, in addition to the current interface referred to in German Published Patent Application No. 198 13 965.

An exemplary embodiment and/or exemplary method of the present invention concerns a method and/or a device for providing bidirectional data transmission between at least two communication devices. The data transmission may be implemented by changes in current flow in one communication direction and by changes in voltage in the other communication direction. Thus, data transmission may be achieved simultaneously in both communication directions on one communication path. In particular, the exemplary embodiment

and/or exemplary method of the present invention (in contrast to German Published Patent Application No. 198 13 965) provides that a bidirectional and simultaneous data transmission may be done in both communication directions. The German Published Patent Application 198 13 965 is incorporated by reference, as necessary.

Since communication from the first communication device, in particular a peripheral device, to the second communication device, in particular a controller, may be implemented via signal edges of the current flow, while the change in voltage levels may represent communication from the controller to the peripheral device, transmission from communication device 1 to communication device 2, i.e., from the peripheral device to the controller (which may be implemented according to the German Published Patent Application referred to above), a rapid digital data transmission from the peripheral device to a controller may be achieved with its characteristic advantages, and in addition, the bidirectional capability of the interface may be achieved by sampling the change in potential on the connecting line.

The Manchester code (in particular, for example, the Manchester II code) may be used for encoding the digital information in both communication directions. This should allow for increasing the data rate through self-synchronizing encoding of the digital data for communication in both directions.

Data transmission from communication device 2, i.e., the controller, to communication device 1, i.e., the peripheral device, may be implementable through any desired coding, i.e., for example the Hamming code or the Abramson code, etc. in addition to the Manchester or Manchester II codes.

The exemplary interface according to the present invention may permit operation of the interface according to ISO Standard

9141 through a variation in the components used (component variant).

When using Manchester coding, synchronization may occur in the middle of a pulse, in particular a data pulse, and thus may be precise due to the pulse edge change occurring there. In Manchester coding, the period of time between two synchronization times in the middle of the pulse may be used as the time range representing the clock frequency. The clock frequency may be detected by counting the oscillator clock pulses and the data acceptance generator may accept the prevailing clock frequency in the current middle of the pulse. The data acceptance generator, however, may detect the pulse levels with a time offset, so it may adjust to these levels in an advantageous way. To utilize one-bit error detection, the two halves of each pulse may be appropriately sampled at least once in the middle of the pulse before and after the synchronization time. Sampling may be performed by multiple sampling within one sampling window. Thus, the advantages with regard to the direction of communication from peripheral device to controller may be preserved and may also be utilized in the opposite direction at the same time.

Thus, in general, simultaneous bidirectional data transmission by both communication devices may be provided, including, for example, asynchronously.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an exemplary device for data transmission according to the present invention.

Figure 2 shows a timing sequence of data transmission from communication device 2 (i.e., the controller) to communication device 1 (i.e., the peripheral device). The transmission is indicated with an intermediate level and also with a true low level by turning it on and off.

DETAILED DESCRIPTION

Figure 1 shows a configuration of the interface, 101 representing a switching logic circuit or semiconductor intelligence, in particular in the form of a microcontroller, etc. At least one peripheral device 100 is connected to switching logic circuit 101. Switching logic circuit 101 having at least one peripheral device 100 forms a communication device K1, for example. A controller may also be provided as communication device 1. Line 114 is the output line from switching logic circuit 101. Line 115 is the input line leading to switching logic circuit 101. Switching logic circuit 101 is connected by line 114 to a consumer 102 which is in turn connected to a switching arrangement 105, in particular a transistor. Switching arrangement 105 is connected to ground and to another consumer 104. Consumer 104 is connected to another consumer 106, which is in turn connected to ground. Another consumer 109 is connected to consumer 104 and consumer 106. On the opposite side, consumer 109 is connected to a potential at pin 108, in particular power supply voltage UBAT. A power storage device, in particular a capacitor 110 which is also connected to ground, is connected to the common potential point of three consumers 104, 106 and 109. The common potential point or common line segment of consumers 104, 106 and 109 as well as power storage device 110 are connected to a comparator 103. A pin 107 is also provided in comparator 103, and a potential VC is applied to it. Comparator 103 is connected at the output to switching logic circuit 101 by line 115. The components and connecting lines described above are parts of periphery P according to the present invention. Periphery P is connected to controller area S via transmission line T. Transmission line T begins in peripheral port Pp, which is connected to comparator 103 via the common line segment described above. The connection of controller area S, i.e., the connection to transmission line T, i.e., the controller port, is labeled as Ps. Transmission line T is connected via port Ps via line 118 to communication device K2 and at the same time to a consumer 111. Consumer 111

is also connected to communication device K2 via a line 117. A power storage device, in particular a capacitor 112, is also connected to line 117 and to ground at the same time. Communication device K2 contains an analyzer circuit or analyzer logic circuit 113 or corresponding semiconductor intelligence in the form of a microcontroller, for example, and an actual microcontroller 116 of a controller. However, analyzer circuit 113 and microcontroller 116 may be accommodated in one integrated module. Thus, 116 may be only a microcontroller or it may be a complete controller, in which case logic circuit 113 may be swapped out.

The interface according to the present invention may require at least one electric connection T between periphery P and controller area S, which transmits data information in both directions. The reference potential, in particular ground, may be the reference potential of the controller via another electric connection or the reference potential may be with respect to another location near the periphery. Switching logic circuit 101 serially performs the pulse-edge control according to Manchester II coding, for output line 114 as well as performing the analysis and further processing of the serially applied voltage levels, e.g., in Manchester II coding, for example for input line 115. Output line 114 is thus the signal path for all data transmissions to the controller, while input line 115 connects the communication between periphery P and switching logic circuit 101.

In addition, switching arrangement 105 is described as a bipolar transistor. However, switching arrangement 105 may also have another configuration, e.g., a unipolar transistor or another switching logic circuit. The base of transistor 105 is controlled via consumer 102 as a voltage divider. If transistor 105 switches, then an increased current flow may be made possible via transmission line T, the potential of transmission line T being maintained because of consumer 104. In addition, a residual current via transmission line T may be

guaranteed via consumer 106 even in the closed state of transistor 105.

Power storage device 110 may be implemented as one or more protective capacitors, and may contribute toward smoothing the edges of the data transmission signal and reducing the emission of transmission line T. Comparator circuit 103 compares the potential of transmission line T with potential VC at pin 107 and thus transmits the coded digital message of controller area S via line 115 to switching logic circuit 101. A power supply voltage, in particular UBAT, i.e., the respective potential at pin 108 is injected via consumer 109.

On controller side S, logic circuit 113 may be implemented by an ASIC, for example. The typical potential on transmission line T is regulated by logic element 113.

If transistor 105 is switched, a voltage drops across consumer 111 and is analyzed between lines 117 and 118 or their inputs in logic element 113. Thus, logic element 113 may receive the coded digital message, processed according to Manchester II coding in particular, from periphery P to controller 9 and may process it further and optionally relay it to microcontroller 116. Power storage device 112 is a protective capacitor for protection from voltage injection or interference injection into logic element 113.

Logic element 113 has the capability through a corresponding control by microcontroller 116 to lower the potential of transmission line T to a residual potential, (e.g., >100 mV) VTl or an intermediate potential VTlz and raise it back to the typical potential on transmission line T again. This change in potential on transmission line T may be applied at the peripheral side to switching logic circuit 110 via line 115 by comparator circuit 103 and the comparison of the potential of transmission line T with the potential at pin 107, VC. The output of comparator circuit 103 thus delivers to switching

logic circuit 101 the coded digital message, in particular coded according to Manchester II, of the communication device, in particular a controller K2, and switching logic circuit 101 may then process it further.

Controller side S may be completely accommodated in the controller and likewise the controller may include only logic module 113 and microcontroller 116 in addition to other components. Then the circuit of elements 111, 112, 117 and 118 may be on the controller side but may be upstream from the actual controller. Likewise, logic element 113 in the form of an ASIC in particular may be upstream from the controller as communication partner K2. Due to this possible swapping out, which may also be possible on peripheral side P, a transmission link which is independent of peripheral device 100 and controller or microcontroller 116 but is connectable to them may be implemented in one device.

The implementation of the interface illustrated in Figure 1 may correspond to the assembly variant addressed above according to ISO Standard 9141. An intermediate potential may be achieved by terminal 108 and consumer 109 which injects its potential. This potential is thus between the residual potential at shutdown by switching arrangement 105 and the potential on activation by switching arrangement 105. This assembly variant yields an interface according to ISO Standard 9141, so that the interface shown here may be operated in accordance with ISO 9141.

The other variant may be obtained by omitting the branch having terminal 108 and consumer 109. Consumers 104 and 106 are dimensioned differently accordingly. Then, however, for simultaneous transmission on both sides, a charge pump, i.e., a power supply may need to be available on both sides.

The timing of the interface is illustrated in Figure 2. Since the communication direction from periphery P to controller

side S may not be sufficiently explicit in German Published Patent Application No. 198 13 965, possible implementations of the communication direction from controller side S to periphery P are illustrated in Figure 2. Implementation of simultaneous transmission in both communication directions may be done, for example, in the following two ways.

As regards the transmission of data from communication device 1 to communication device 2, this may be obtained from German Published Patent Application No. 198 13 965.

The first one is an implementation having intermediate potential VTlz, illustrated in signal flow SPl with a one-sided power supply, i.e., on peripheral side P or controller side S of the transmission link, in particular through the branch described previously having terminal 108 and consumer 109.

The second one is to provide separate power supplies for peripheral side P and controller side S if they do not obtain their power via electric connection T of the interface. Then it may be necessary only to ensure that the interface be repeatedly activatable and deactivatable.

Figure 2 shows potential VT on transmission line T plotted as a function of time. VTh shows a high potential and VTl shows the above-mentioned residual potential or low potential. An intermediate level VTlz, an intermediate low level, so to speak, is also illustrated at the first one.

The activation operation applies a potential VTh at t1. The actual transmission of data is then represented by at least one start bit from t2 to t3 at time t2. In this diagram, Manchester II coding has again been selected, according to which synchronization occurs in the middle of a pulse, making it possible to utilize Manchester II coding for both communication directions. At time t3 there is then optionally

another start bit or already the first data bit. Following that, additional data bits are transmitted at times t4 and t5. For example, a total of 8 data bits, i.e., one byte, may be transmitted per transmission frame. Following the data at time t6, then a parity bit for data checking is transmitted, and finally at time t7, a stop bit for frame limiting is transmitted.

The digital messages may be encoded according to Manchester II coding, as mentioned above, or according to other, in particular cyclic, codes such as the Hamming or Abramson codes.

The low level for SP1 here corresponds to an intermediate level which is less than high level VTh. This level VTlz at the same time may ensure an adequate current flow (not shown here) for the opposite direction from communication device 1 to communication device 2. Thus, one power supply on one side of the transmission link may be sufficient.

In the second case, with power supplies on both sides of the transmission link, the signal is changed from low level VTl to high level VTh during activation operation at t11. Here again, at time t21, the transmission is begun at signal SP2, as in the case of SP1, with at least one start bit. At time t31, another start bit or the first data bit may be transmitted. Another data bit is transmitted at time t41. The remaining course corresponds to that of SP1, the difference being that the change between low potential VTl and high potential VTh is performed.

Since the current flow associated with low potential VTl in the opposite direction from K1 to K2 may not be sufficient for data transmission, use of a separate power supply on peripheral side P and controller side S may be necessary for a simultaneous transmission. Otherwise, i.e., in the case of SP2 without bilateral power supply, the interface may be switched

off at low level VTl and no communication may be possible from the periphery to the controller, i.e., from K1 to K2 via changes in current flow. Thus, the communication directions may have to be loaded with a time offset, so that communication may occur with a time offset as in the related art.

In both cases SP1 and SP2, after termination of the communication, the level of transmission line T is again returned to high potential Vth with the stop bit at t7 or similarly with a stop bit at SP2.

Through the methods and devices presented here, it may be possible to take into account the high requirements in the automotive field, regarding data security, data rate and cost of the system implementation in particular. In addition, a possibility may be created of detecting data failures during data transmission and compensating for them, in which case a greater robustness with regard to electromagnetic compatibility effects may also be achieved at the same time.

These methods and devices may be used, as mentioned above, independently of a specific application and in cases where data transmission between at least two communication devices is desired. In addition to the airbag system mentioned here, other possible applications may include drive control, suspension and brake regulation as well as automatic transmission control operations, etc. Likewise, communication of other electronic devices such as door locks or window control with a controller may also be included.

ABSTRACT OF THE DISCLOSURE

A method and a device for providing bidirectional data transmission between at least two communication devices is described, the data transmission in one communication direction being implemented by changes in current flow and in the other communication direction by changes in a voltage, the data transmission in both communication directions being implementable simultaneously on one communication path, one power supply being maintained for both communication directions through a steady minimum voltage level and/or minimum current flow level or a separate power supply being maintained for each communication device.

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[10191/2363]

METHOD AND DEVICE FOR BIDIRECTIONAL COMMUNICATION BETWEEN AT LEAST TWO COMMUNICATION DEVICES

Background Information

The present invention relates to a method and a device for bidirectional data transmission between at least two communication devices according to the preambles of the independent claims. In particular, data is transmitted between a peripheral device and a controller in an airbag system.

In this regard, German Patent Application 196 09 290 A1 describes an airbag system for protecting the occupants of a vehicle. This provides for a plurality of sensor modules which are connected via pairs of lines to a controller situated at a distance. The controller controls a restraint device for vehicle occupants such as an airbag in particular. The output signals of the sensor modules are transmitted to the controller in the form of sequential changes in the current flow on both lines, i.e., in the form of analog push-pull signals or in the form of a pulse train. In the opposite direction, namely from the controller to the sensor modules, the data is implemented by sequential changes in voltage. The communication takes place with a time offset, i.e., the controller signals the start of transmission to the sensor modules on the basis of a request signal in the form of sequential changes in voltage, and following that in the opposite direction, i.e., from the sensor modules to the controller, data is transmitted in the form of sequential changes in current flow via the line pair.

With regard to the current interface, i.e., usually the direction of transmission from the sensor modules to the controller, German Patent Application 198 13 965.9 (not a

prior publication), describes a method of transmitting digital data with a clock acceptance generator whose clock frequency is controllable. Data transmission from a peripheral device to a controller by signal edges of the current flow in a special shape is described here. The coding of the binary states is thus defined by a rising or a falling signal edge, which must be detected in a certain time window. Through the additional use of Manchester coding, the data acceptance clock generator frequency may be synchronized. The time shift occurring here between the data pulses and the synchronization times of the pulse-edge changes is taken into account by a time-offset sampling of the logic levels of the data pulses. If bidirectional transmission according to this method were used, a time-offset data transmission would also have to be used here.

In addition to the Manchester or Manchester II coding mentioned above, other coding methods, in particular cyclic coding methods, are also known in data transmission technology, e.g., the Hamming code or the Abramson code, etc.

The object of the present invention is to implement a refinement on the basis of the description of German Patent Application 198 13 965.9 (not a prior publication), to the extent that simultaneous bidirectional data transmission in both directions is possible in addition to the current interface described there.

Advantages of the Invention

The present invention is based on a method and a device for bidirectional data transmission between at least two communication devices, the data transmission being implemented by changes in current flow in one communication direction and by changes in voltage in the other communication direction, data transmission being achievable simultaneously in both communication directions on one communication path. In

particular, the present invention improves upon the content of German Patent Application 198 13 965.9 (not a prior publication), to the extent that a bidirectional and simultaneous data transmission is possible in both communication directions. Thus, the content of German Patent Application 198 13 965.9 is also included in the content of the present invention presented here.

Due to the fact that communication from the first communication device, in particular a peripheral device, to the second communication device, in particular a controller, is implemented by signal edges of the current flow, while the change in voltage levels represents communication from the controller to the peripheral device, transmission from communication device 1 to communication device 2, i.e., from the peripheral device to the controller being implemented according to the above German Patent Application (not a prior publication), a rapid digital data transmission from the peripheral device to a controller is achieved with its characteristic advantages, and in addition, the bidirectional capability of the interface is achieved by sampling the change in potential on the connecting line.

The Manchester code, in particular the Manchester II code, may be accepted to advantage for encoding the digital information in both communication directions. This makes it possible to increase the data rate through self-synchronizing encoding of the digital data for communication in both directions.

It is advantageous that data transmission from communication device 2, i.e., the controller, to communication device 1, i.e., the peripheral device, is implementable through any desired coding, i.e., for example the Hamming code or the Abramson code, etc. in addition to the Manchester or Manchester II codes.

The interface according to the present invention may

advantageously permit operation of the interface according to ISO Standard 9141 through a simple variation in the components used (component variant).

When using Manchester coding, synchronization takes place in the middle of a pulse, in particular a data pulse, and is thus advantageously always possible and precise due to the pulse edge change occurring there. In Manchester coding, the period of time between two synchronization times in the middle of the pulse is advantageously used as the time range representing the clock frequency. Due to the fact that the clock frequency is detected by the essentially known counting of the oscillator clock pulses and the data acceptance generator accepts the prevailing clock frequency in the current middle of the pulse, but the data acceptance generator, however, detects the pulse levels with a time offset, so it adjusts to these levels to advantage. To be able to utilize one-bit error detection, which is another advantage of Manchester coding, the two halves of each pulse are appropriately sampled at least once in the middle of the pulse before and after the synchronization time. Sampling is advantageously performed by multiple sampling within one sampling window. Thus, the advantages with regard to the direction of communication from peripheral device to controller are preserved completely and may also be utilized in the opposite direction at the same time.

Thus, in general, simultaneous bidirectional data transmission by both communication devices is possible to advantage, preferably asynchronously.

Other advantageous embodiments are derived from the description and claims.

Drawing

Figure 1 shows a possible basic design of a device for data

transmission according to the present invention.

Figure 2 shows in principle data transmission from communication device 2, i.e., the controller, to communication device 1, i.e., the peripheral device. The transmission is indicated with an intermediate level and also with a true low level by turning it on and off.

Transmission of data from communication device 1 to communication device 2 is described in German Patent Application 198 13 965.9 (not a prior publication), the content of which is also included here.

Description of the Exemplary Embodiments

Figure 1 shows the basic design of the interface, 101 representing a switching logic circuit or semiconductor intelligence, in particular in the form of a microcontroller, etc. At least one peripheral device 100 is connected to switching logic circuit 101. Switching logic circuit 101 having at least one peripheral device 100 forms a communication device K1, for example. A controller may also be provided as communication device 1. Line 114 is the output line from switching logic circuit 101. Line 115 is the input line leading to switching logic circuit 101. Switching logic circuit 101 is connected by line 114 to a consumer 102 which is in turn connected to a switching means 105, in particular a transistor. Switching means 105 is connected to ground and to another consumer 104. Consumer 104 is connected to another consumer 106, which is in turn connected to ground. Another consumer 109 is connected to consumer 104 and consumer 106. On the opposite side, consumer 109 is connected to a potential at pin 108, in particular power supply voltage UBAT. A power storage device, in particular a capacitor 110 which is also connected to ground, is connected to the common potential point of three consumers 104, 106 and 109. The common potential point or common line segment of consumers 104, 106

and 109 as well as power storage device 110 are connected to a comparator 103. A pin 107 is also provided in comparator 103, and a potential VC is applied to it. Comparator 103 is connected at the output to switching logic circuit 101 by line 115. The components and connecting lines described above are parts of periphery P according to the present invention. This periphery P is connected to controller area S via transmission line T. Transmission line T begins in peripheral port Pp, which is connected to comparator 103 via the common line segment described above. The connection of controller area S, i.e., the connection to transmission line T, i.e., the controller port, is labeled as Ps. Transmission line T is connected via port Ps via line 118 to communication device K2 and at the same time to a consumer 111. Consumer 111 is also connected to communication device K2 via a line 117. A power storage device, in particular a capacitor 112, is also connected to line 117 and to ground at the same time. Communication device K2 contains an analyzer circuit or analyzer logic circuit 113 or corresponding semiconductor intelligence in the form of a microcontroller, for example, and an actual microcontroller 116 of a controller. However, it is also conceivable for analyzer circuit 113 and microcontroller 116 to be accommodated in one integrated module. Thus, 116 may be only a microcontroller or it may be a complete controller, in which case logic circuit 113 may be swapped out.

The interface according to the present invention requires at least one electric connection T between periphery P and controller area S, which transmits data information in both directions. The reference potential, in particular ground, may be the reference potential of the controller via another electric connection (not shown here) or the reference potential may be with respect to another location near the periphery. Switching logic circuit 101 serially performs the pulse-edge control according to Manchester II coding, for output line 114 as well as performing the analysis and further

processing of the serially applied voltage levels, e.g., in Manchester II coding, for example for input line 115. Output line 114 is thus the signal path for all data transmissions to the controller, while input line 115 connects the communication between periphery P and switching logic circuit 101.

In addition, switching means 105 is described as a bipolar transistor. However, switching means 105 may also have another design, e.g., a unipolar transistor or another switching logic circuit. The base of transistor 105 is controlled via consumer 102 as a voltage divider. If transistor 105 switches, then an increased current flow is made possible via transmission line T, the potential of transmission line T being maintained because of consumer 104. In addition, a residual current via transmission line T may be guaranteed via consumer 106 even in the closed state of transistor 105.

Power storage device 110 may be implemented as one or more protective capacitors, and it contributes toward smoothing the edges of the data transmission signal and reducing the emission of transmission line T. Comparator circuit 103 compares the potential of transmission line T with potential VC at pin 107 and thus transmits the coded digital message of controller area S via line 115 to switching logic circuit 101. A power supply voltage, in particular UBAT, i.e., the respective potential at pin 108 is injected via consumer 109.

On controller side S, logic circuit 113 may be implemented by an ASIC, for example. The typical potential on transmission line T is regulated by logic element 113.

If transistor 105 is switched, a voltage drops across consumer 111 and is analyzed between lines 117 and 118 or their inputs in logic element 113. Thus, logic element 113 may receive the coded digital message, processed according to Manchester II coding in particular, from periphery P to controller 9 and

process it further and optionally relay it to microcontroller 116. Power storage device 112 is a protective capacitor for protection from voltage injection or interference injection into logic element 113.

Logic element 113 has the capability through a corresponding control by microcontroller 116 to lower the potential of transmission line T to a residual potential, (e.g., >100 mV) VTl or an intermediate potential VTlz and raise it back to the typical potential on transmission line T again. This change in potential on transmission line T may be applied at the peripheral side to switching logic circuit 110 via line 115 by comparator circuit 103 and the comparison of the potential of transmission line T with the potential at pin 107, VC. The output of comparator circuit 103 thus delivers to switching logic circuit 101 the coded digital message, in particular coded according to Manchester II, of the communication device, in particular a controller K2, and switching logic circuit 101 may then process it further.

Controller side S may be completely accommodated in the controller and likewise the controller may include only logic module 113 and microcontroller 116 in addition to other known components. Then the circuit of elements 111, 112, 117 and 118 would be on the controller side but would be upstream from the actual controller. Likewise, logic element 113 in the form of an ASIC in particular could be upstream from the controller as communication partner K2. Due to this possible swapping out, which is also possible on peripheral side P, a transmission link which is independent of peripheral device 100 and controller or microcontroller 116 but is connectable to them may be implemented in one device.

The implementation of the interface illustrated in Figure 1 corresponds to the assembly variant addressed above according to ISO Standard 9141. An intermediate potential is achieved by terminal 108 and consumer 109 which injects its potential.

This potential is thus between the residual potential at shutdown by switching means 105 and the potential on activation by switching means 105. This assembly variant yields an interface according to ISO Standard 9141, so that the interface shown here may be operated in accordance with ISO 9141.

The other variant is obtained by omitting the branch having terminal 108 and consumer 109. Consumers 104 and 106 are dimensioned differently accordingly. Then, however, for simultaneous transmission on both sides, a charge pump, i.e., a power supply must be available on both sides.

The timing of the interface is illustrated in Figure 2. Since the communication direction from periphery P to controller side S is not adequately described in German Patent Application 198 13 965.9 (not a prior publication), and its content is also included in the present patent application, possible implementations of the communication direction from controller side S to periphery P are illustrated in Figure 2. Two possibilities are presented for implementation of simultaneous transmission in both communication directions.

The first one is an implementation having intermediate potential VTlz, illustrated in signal flow SPl with a one-sided power supply, i.e., on peripheral side P or controller side S of the transmission link, in particular through the branch described previously having terminal 108 and consumer 109.

The second possibility is to provide separate power supplies for peripheral side P and controller side S if they do not obtain their power via electric connection T of the interface. Then it is necessary only to guarantee that the interface be repeatedly activatable and deactivatable.

Figure 2 shows potential VT on transmission line T plotted as

a function of time. VTh shows a high potential and VTl shows the above-mentioned residual potential or low potential. An intermediate level VTlz, an intermediate low level, so to speak, is also illustrated at possibility 1.

The activation operation applies a potential VTh at t1. The actual transmission of data is then represented by at least one start bit from t2 to t3 at time t2. In this diagram, Manchester II coding has again been selected, according to which synchronization takes place in the middle of a pulse, making it possible to utilize the advantages of Manchester II coding for both communication directions. At time t3 there is then optionally another start bit or already the first data bit. Following that, additional data bits are transmitted at times t4 and t5. For example, a total of 8 data bits, i.e., one byte, may be transmitted per transmission frame. Following the data at time t6, then a parity bit for data checking is transmitted, and finally at time t7, a stop bit for frame limiting is transmitted.

The digital messages may be encoded according to Manchester II coding, as mentioned above, or according to other, in particular cyclic, codes such as the Hamming or Abramson codes.

The low level for SP1 here corresponds to an intermediate level which is less than high level VTh. This level VTlz at the same time guarantees an adequate current flow for the opposite direction (not shown here) from communication device 1 to communication device 2. Thus, one power supply on one side of the transmission link is sufficient.

In the second case, with power supplies on both sides of the transmission link, the signal is changed from low level VTl to high level VTh during activation operation at t11. Here again, at time t21, the transmission is begun at signal SP2, as in the case of SP1, with at least one start bit. At time t31,

another start bit or the first data bit may be transmitted. Another data bit is transmitted at time t41. The remaining course corresponds to that of SP1, the difference being that the change between low potential VTl and high potential VTh is performed.

Since the current flow associated with low potential VTl in the opposite direction from K1 to K2 is not sufficient for data transmission, use of a separate power supply on peripheral side P and controller side S is necessary for a simultaneous transmission. Otherwise, i.e., in the case of SP2 without bilateral power supply, the interface would be switched off at low level VTl and no communication would be possible from the periphery to the controller, i.e., from K1 to K2 via changes in current flow. Thus, the communication directions would have to be loaded with a time offset, so that communication would take place with a time offset as in the related art.

In both cases SP1 and SP2, after termination of the communication, the level of transmission line T is again returned to high potential Vth with the stop bit at t7 or similarly with a stop bit at SP2 (not shown).

Through the methods and devices presented here, it is possible to take into account the high requirements in the automotive field, regarding data security, data rate and cost of the system implementation in particular. In addition, the possibility is created of detecting data failures during data transmission and compensating for them, in which case a greater robustness with regard to electromagnetic compatibility effects is also achieved at the same time.

These methods and devices may be used, as mentioned above, independently of a specific application and in all cases where data transmission between at least two communication devices is desired. In addition to the airbag system mentioned here,

other possible applications include drive control, suspension and brake regulation as well as automatic transmission control operations, etc. Likewise, communication of other electronic devices such as door locks or window control with a controller is also included.

New Claims

What is claimed is:

1. A method of bidirectional data transmission between at least two communication devices, the data transmission being implemented in one communication direction by changes in a current flow and in the other communication direction by changes in a voltage,
wherein the data transmission in both communication directions is implementable simultaneously on one communication path, by implementing one power supply for both communication directions, through a steady minimum level of the voltage and/or the current flow, or by maintaining a separate power supply for each communication device; at least in the case of the communication direction of data transmission implemented by changes in current flow, the data pulses implementing the data being generated with an inverted pulse half and a non-inverted pulse half, and those being Manchester-coded with a pulse-edge change between the pulse halves.

2. The method according to Claim 1,
wherein the data transmission takes place through changes in voltage so that, in addition to a high level and a low level of the voltage, an intermediate voltage level is set, and the data is represented by changing between the high level and the intermediate level.

3. The method according to Claims 1 and 2,
wherein the minimum level corresponds to the intermediate level.

4. The method according to Claim 1,
wherein the data transmission is implemented by changes in voltage, occurs such that, in addition to a high level, a low voltage level is set, and the data is represented by changing between the high level and low level.

5. The method according to Claim 1,
wherein in the case of the communication direction of the data transmission implemented by changing the voltage, the data pulses implementing the data are generated with an inverted pulse half and a non-inverted pulse half, and they are encoded with an edge change between the pulse halves, using a cyclic code, in particular the Manchester code, Hamming code or Abramson code.

6. A device for bidirectional data transmission between at least two communication devices having first means which execute the data transmission in one communication direction through changes in current flow and second means which execute the data transmission in the other communication direction through changes in voltage,
wherein there is one communication path on which the data transmission is implemented simultaneously in both communication directions; using first and/or second means, one power supply is maintained for both communication directions through a constant minimum level of voltage and/or current flow, or a separate power supply is maintained for each communication device; fourth means being included which, at least in the case of the communication direction of data transmission implemented by through changes in current flow, generate the data-implementing data pulses with an inverted pulse half and a non-inverted pulse half and code the data pulses with an edge change between the pulse halves, using Manchester coding.

7. The device according to Claim 6,
wherein third means are included, which carry out the data transmission implemented by changes in voltage so that, in addition to a high level, a low level voltage is set, and the data is represented by changing between the high level and the low level; a separate power supply being included for each communication direction.

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8. The device according to Claim 6,
wherein third means are included, which carry out the data transmission implemented by changes in voltage so that, in addition to a high level and low level of the voltage, an intermediate voltage level is set, and the data is represented by changing between the high level and the intermediate level.

9. The device according to Claim 6,
wherein fifth means are included which, in the case of the communication direction of data transmission implemented by changes in voltage, generate data-implementing data pulses with an inverted pulse half and a non-inverted pulse half and encode these pulses with an edge change between the pulse halves, using a cyclic code, in particular the Manchester code, the Hamming code or the Abramson code.

Abstract

A method and a device for bidirectional data transmission between at least two communication devices is described, the data transmission in one communication direction being implemented by changes in current flow and in the other communication direction by changes in a voltage, the data transmission in both communication directions being implementable simultaneously on one communication path, one power supply being maintained for both communication directions through a steady minimum voltage level and/or minimum current flow level or a separate power supply being maintained for each communication device.

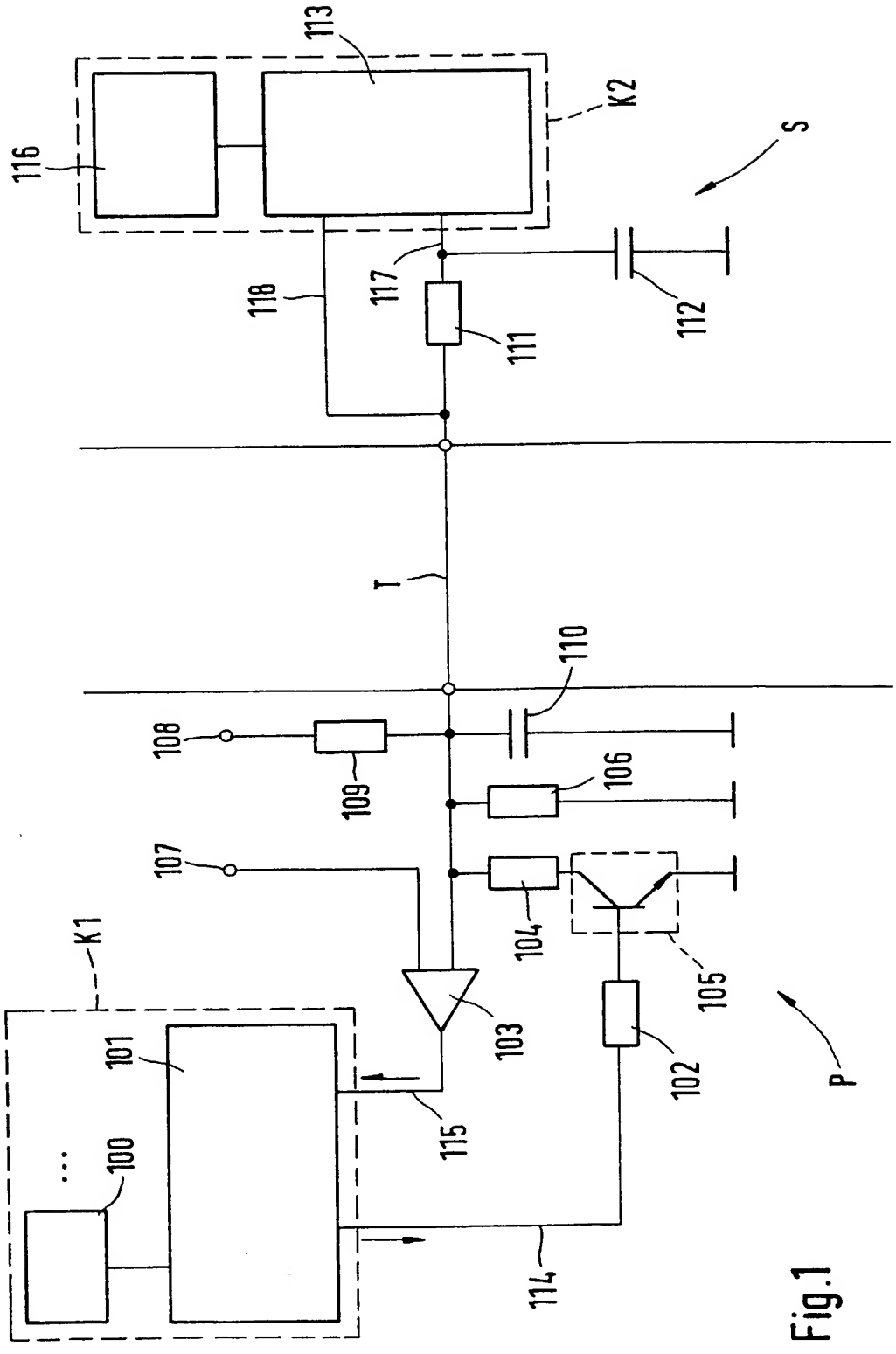
113
K2
116
S
117
118
112
111
T
110
108
109
106
107
104
105
K1
103
101
102
P
100
115
114

Fig.1

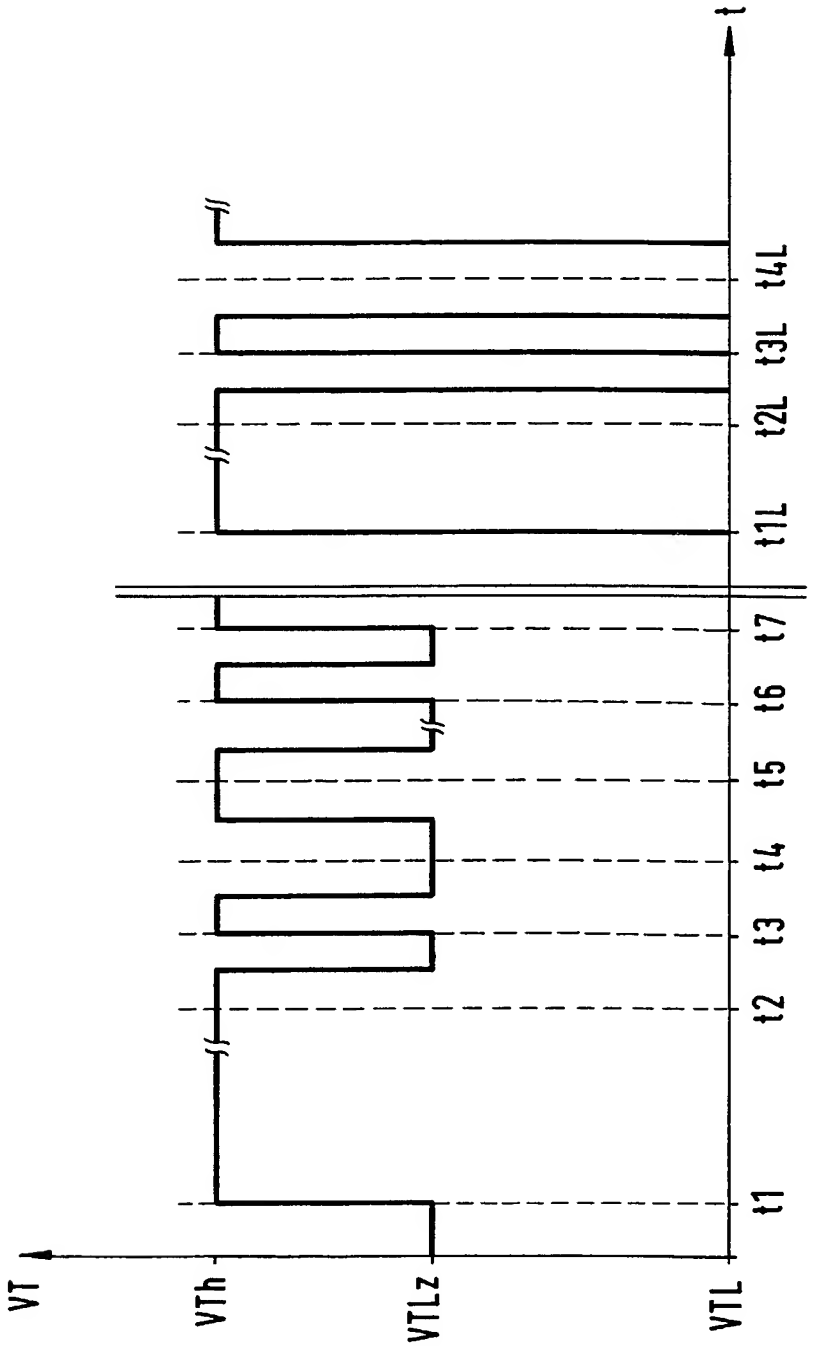

Fig.2

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **METHOD AND DEVICE FOR BIDIRECTIONAL COMMUNICATION BETWEEN AT LEAST TWO COMMUNICATIONS SUBSCRIBERS**, the specification of which was filed as International Application No. PCT/DE00/02478 on July 28, 2000.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Number	Country filed	Day/month/year	Priority Claimed Under 35 USC 119
199 46 776.5	Federal Republic of Germany	29 September 1999	Yes

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And I hereby appoint Richard L. Mayer (Reg. No. 22,490) and Gerard A. Messina (Reg. No. 35,952) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful and false statements may jeopardize the validity of the application or any patent issued thereon.

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